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DRS Technologies: A.I. D'Souza, M.G. Stapelbroek, R. Willis, S. Masterjohn, P. Dolan, M. Alderete, E. Bryana, ITT industries: J.C. Ehlert, J.E. Andrews, Rockwell Scientific Co,: P.S. Wijewarnasuriyab, E. Boehmer, S. Bhargava					ITT A/CD – CRIS DRS Technology – CRIS Rockwell Scientific – CRIS

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9. WAS ANY WORK DESCRIBED DONE UNDER CONTRACT? (IF SO, COMPLETE 10, 11, AND 12.) YES [x] NO [ ]

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SIGNATURE J. L C. Ehlert
TYPED NAME: John Ehlert, ITT A/CD
DATE

14. ORGANIZATION/PROGRAM DESIGNEE
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TITLE: I-V, Noise and Visual Defect Analysis in Large Area $Hg_{1-x}Cd_xTe$ Photodiodes

PRESENTER: Arvind I. D'Souza

BUSINESS ADDRESS: **DRS Sensors & Targeting Systems**
3330 Miraloma Avenue
Anaheim, CA 92806

AUTHOR TO BE NOTIFIED:

Arvind I. D'Souza

Tel: 714-762-0836

Fax: 714-762-2415

e-mail: arvind.d'souza@drs-sts.com

I-V, Noise and Visual Defect Analysis in Large Area $Hg_{1-x}Cd_xTe$ Photodiodes

A.I. D'Souza, M.G. Stapelbroek, R. Willis, S. Masterjohn, P. Dolan, M. Alderete, E. Bryan[a]
DRS Sensors & Targeting Systems, 3330 Miraloma Avenue, Anaheim, CA 92806

J.C. Ehlert, J.E. Andrews
ITT Industries, 1919 W. Cook Rd., Ft. Wayne, IN 46818

P.S. Wijewarnasuriya[b], E. Boehmer, S. Bhargava
Rockwell Scientific Company, 5212 Verdugo Way, Camarillo, CA 93012

a. Presently at Raytheon, El Segundo, CA
b. Presently at US Army Research Laboratory, 2800 Powder Mill Road, Adelphi, MD 20783

ABSTRACT

Sounder applications require large area detectors that have high performance and linear photoresponse. Photodiodes (as compared to photoconductors) provide such a linear response and are therefore highly desirable for infrared sounders. The Cross-track Infrared Sounder (CrIS) program (an instrument on the National Polar-orbiting Operational Environmental Satellite System – NPOESS) requires detectors with spectral cut-offs denoted by SWIR [λ_c(98 K) ~ 5 μm], MWIR [λ_c(98 K) ~ 9 μm] and LWIR [λ_c(81 K) ~ 15 μm]. The CrIS instrument also requires large-area (850-μm-diameter) detectors with state-of-art detector performance. Molecular Beam Epitaxy (MBE) is used to grow *n*-type SWIR, MWIR or LWIR $Hg_{1-x}Cd_xTe$ on lattice matched CdZnTe. Detectors with *p*-type implants 7 μm in diameter are used to constitute the 850-μm-diameter Lateral Collection Diodes (LCDs). The detector architecture is the Double Layer Planar Heterostructure (DLPH) architecture.

Quantum efficiency, *I-V*, $R_d - V$ and *1/f* noise in photovoltaic $Hg_{1-x}Cd_xTe$ detectors are critical parameters that limit the sensitivity of infrared sounders. These parameters are used to select the detectors that will be part of the CrIS Focal Plane Module (FPM). However, the detectors are subject to a significant amount of handling while transitioning from detectors as part of newly processed $Hg_{1-x}Cd_xTe$ wafers to detectors mounted in a CrIS FPM ready to be flown on NPOESS.

I-V, noise and visual inspections are performed at several steps in the detector journey. Initial *I-V* and visual inspections are conducted at the wafer level followed by *I-V*, noise (both in a dark and photo environment), quantum efficiency and visual inspection prior to and following removal of the detectors from Leadless Chip Carriers (LCCs). Finally, the detectors are precision mounted on a FPM base and *I-V*, noise and visual inspections are performed again.

Figure 1 is a graph of the *I-V* curves before and after damage was imparted to the *p*-side metal covering the 850-μm-diameter LCD. The detector has λ_c(81 K) ~ 15 μm. The *I-V* characteristics changed from being limited by diffusion currents at low reverse bias (out to ~ -50 mV) and tunneling current at higher reverse bias values to almost a short dominated by a

shunt-type current. Figure 2 is a picture of the damage sites. Figure 3 is a picture of another LWIR detector that suffered damage during wirebonding. This resulted in the CdTe passivation layer developing a crack. The *I-V* for this detector also suffered degradation similar to that shown in Figure 1.

Initial notice of detector *I-V* and noise characteristics degradation resulted in an investigation to discern the cause of the degradation (baking at elevated temperatures, mechanical handling, electrical stress *etc.*). This paper will outline the results of the study and the corrective actions that led to the successful manufacture of LWIR large detectors from the material growth to insertion into flight focal plane modules for the CrIS program.

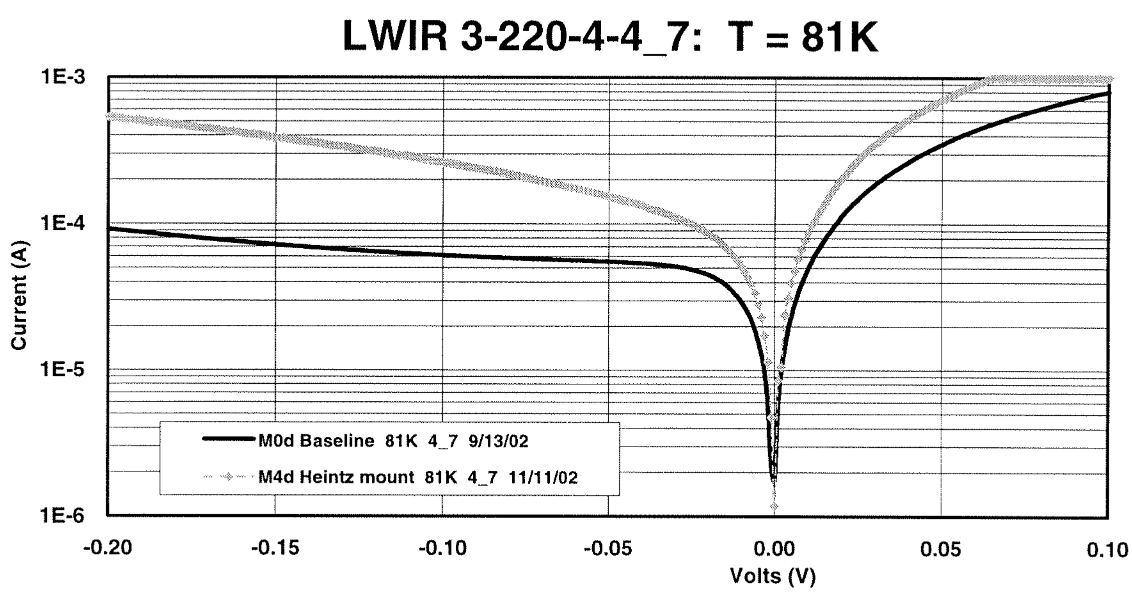

Figure 1. LWIR $\lambda_c(81\ K) \sim 15\ \mu m$ *I-V* before and after damage to the *p*-side metal

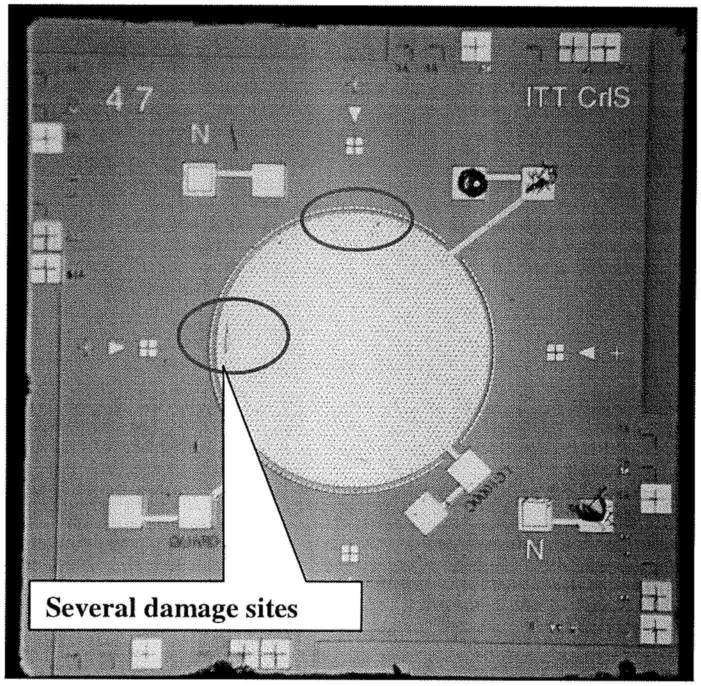

Figure 2. *p*-side metal damage

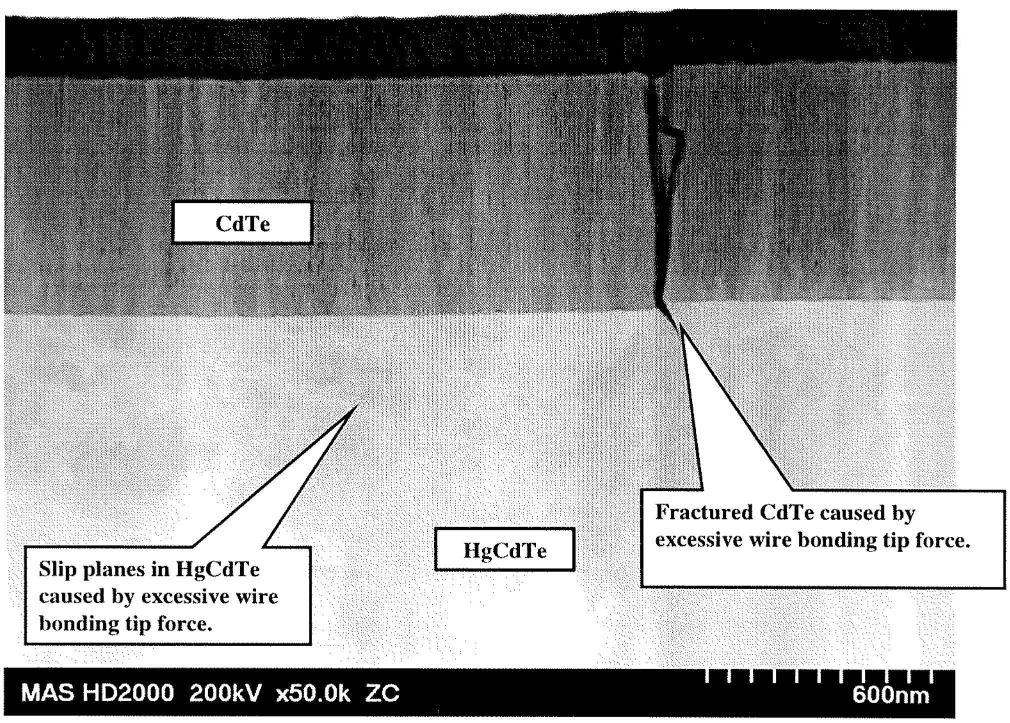

Figure 3. Damage induced by wirebonding to the *p*-side pad for an LWIR [$\lambda c(81\ K) \sim 15\ \mu m$] diode.